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COMPARATIVE STUDY ON DURABILITY CHARACTERISTICS OF HIGH STRENGTH SELF COMPACTING CONCRETE

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ABSTRACT

Environmental concerns have led to severe restrictions on dredging for sand in much of India, leading to direct impacts on the economics of concrete construction. At the same time, waste plastic is rarely recycled across India, with a large proportion of plastic simply exposed of into landfill presenting further environmental concerns. This paper describes a study seeking a solution to both problems by utilizing processed waste plastics as a partial replacement for fine aggregate in self compacting concrete mixes. Self compacting concrete is considered as a concrete that can be placed and compacted under its own weight without any vibration effort. In this experimental work, High strength self compacting concrete is obtained by replacing plastic scraps from waste plastic material. The fine aggregate is substituted with the plastic scrap at dosages 0%, 5%, 10%, 15%, and 20% by weight of the fine aggregate. The study was made using the scraps as a partial replacement for fine aggregate. The optimum percentage for the self compacting concrete can be evaluated by testing the specimen for its compressive and tensile strength. From the optimum percentage, the durability of the self compacting concrete can be evaluated using test such as, acid attack, sulphate attack test.

Key words: Self compacting concrete, Fine aggregate replacement, Plastic scraps.

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1. INTRODUCTION

The use of self compacting concrete saw a huge development in last decades due to the rapid development in the construction field to reduce cost, labour, time and other important factors. On the other hand due to very low biodegradability, plastic gives much pressure to the environment. By grinding the plastic waste into small pieces to replace fine aggregate in concrete the waste can be managed.

The self compacted concrete is widely used in pre or post tensioned sections. It has good ability to mould in any shape with the help of mould. This is used where the reinforcement is in a way that there are very congested areas in which the compaction equipments i.e. vibrating machine are not able to function,. And with the help of this we can reduce the compaction cost those equal to the one tenth of the over all cost of the structure. Self-consolidating concrete (SCC) is a highly flow able concrete that can spread into place under its own weight and achieve good consolidation in the absence of vibration without exhibiting defects due to segregation and bleeding. Self-consolidating concrete is a product of technological advancements in the area of underwater concrete technology where the mix is proportioned to insure high fluidity as well as high resistance to water dilution and segregation. The use of SCC has gained wide acceptance in Japan since the late 1980s for casting congested members, as well as the placement of concrete in restricted areas where consolidation may not be practical.

2. MATERIALS AND PROPERTIES

This chapter present the materials properties as found by laboratory tests. All the material tests were conducted in the laboratory as per relevant Indian Standard codes. Basic test were conducted on Cement, fine aggregate, coarse aggregate to check their suitability of concrete.

2.1. Ordinary Portland Cement–53 Grade

The cement used was ordinary Portland cement of 53- grade conforming to IS 12269

Table 1 Properties of Cement

S.NO	Property	Result obtained
1	Specific gravity	3.15
2	Fineness (m^2/kg)	225
3	Initial setting time (minutes)	30
4	Final setting time (minutes)	585

2.2. Plastic Scraps

The plastic waste Polyethylene terephthalate (PET) used in this experiment has less weight and tight particle size when compared to fine aggregate.

Table 2 Properties of Plastic scraps

S.NO	Property	Value
1	Apparent density	510 kg/m^3
2	Specific gravity	960 kg/m^3
3	Water absorption	0.01%
4	Specific surface	1.67 m^2/kg

2.3. Aggregate

The maximum size of the coarse aggregate was 12mm. Natural river sand sieved in 4.75mm sieve is used in this study.

Table 3 Properties of Fine aggregate

S.NO	Property	Value
1	Apparent density	1520 kg/m^3
2	Specific gravity	26100 kg/m^3
3	Water absorption	1.03%
4	Specific surface	6.24 m^2/kg

2.4. Super Plasticiser (Master Glenium SKY 8233)

An admixture based on modified polycarboxylic ether helps to produce high performance concrete with longer workability retention which eliminates vibration and free of chloride and low alkali.

Table 4 Properties of Super Plasticiser

S.NO	Property	Value
1	Aspect	light brown liquid
2	Relative density	1.08 ± 0.01 at 25℃
3	pH	≥6
4	Chloride ion content	<0.2%

2.5. Viscosity Modifying Agent (Master Matrix 102)

This organic, liquid viscosity modifying agent is used to produce concrete with enhanced viscosity and controlled rheological properties.

Table 5 Properties of viscosity modifying agent

S.NO	Property	Value
1	Aspect	Colourless free flowing liquid
2	Relative density	1.01 ± 0.01 at 25℃
3	pH	≥6 at 25℃
4	Chloride ion content	<0.2%

3. EXPERIMENTAL INVESTIGATION AND RESULT ANALYSIS

In this experimental work the four mixes were studied. The Mix M is the conventional, Mix 1 (5% plastic scrap), Mix 2 (10% plastic scrap), Mix 3 (15% plastic scrap) and Mix 4 (20%plastic scrap) are taken into consideration**.**

3.1. Workability Test

Workability tests like slump flow test, V-funnel test, U-box test, L-box test were conducted and the results obtained from the tests are given in

Table 6 Workability test

S.No	Tests	Unit	Mix M	Mix 1	Mix 2	Mix 3	Mix 4
1	Slump flow	mm	670	696	710	715	722
2	V-funnel	sec	8	9	7	8	9
4	U-box	(h2-h1)mm	23	21	21	23	25
5	L-box	(h2/h1)mm	0.93	0.77	0.90	0.89	0.94

3.2. Test of Mechanical Properties

3.2.1. Compressive Strength Test

Concrete cubes of size 150mm×150mm×150mm were casted. After 24 hours, the specimens were de-moulded and subjected to curing for 7 days, 14 days &28 days in portable water. After curing, the specimens were tested for compressive strength using compression testing machine of 2000KN capacity as per BIS: 516-1959.

Table 7 Compressive strength test result

S. No	Description of specimen	Specimen Weight (kg)	Compressive strength (N/mm²)		
			7Days	14 Days	28 Days
1.	Mix M	8.46	28.26	39.11	43.51
2.	Mix 1	8.35	28.31	39.51	43.64
3.	Mix 2	8.40	28.71	40.66	44.88
4.	Mix 3	8.35	29.73	40.57	45.06
5.	Mix 4	8.10	29.02	38.89	44

Figure 1 Test Specimen

Figure 2 Compression Failure

3.2.2. Split Tensile Strength Test

Concrete cylinders of size 150 mm diameter and 300mm length were cast with plastic scrap as partial replacement of dine aggregate. After 24 hours, the specimens were de-moulded and subjected to curing for 7 days, 14 days &28 days in portable water. After curing, the cylindrical specimens were tested for split tensile strength using compression testing machine of 2000kN capacity.

Table 8 Split tensile strength test result

S. No	Description of specimen	Specimen Weight (kg)	Split tensile strength (N/mm²)		
			7 Days	14 Days	28 Days
1.	Mix M	12.97	0.82	3.13	3.68
2.	Mix 1	10.21	0.79	3.25	3.66
3.	Mix 2	9.55	0.82	3.32	3.72
4.	Mix 3	8.30	0.86	3.42	3.75
5.	Mix 4	7.04	0.81	3.14	3.69

Figure 3 Test specimen **Figure 4** Tensile Failure

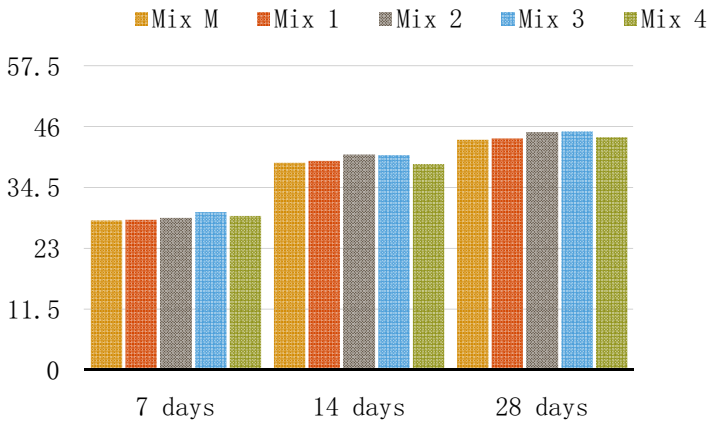

Figure 5 Graph of the comparison of compressive strength of concrete

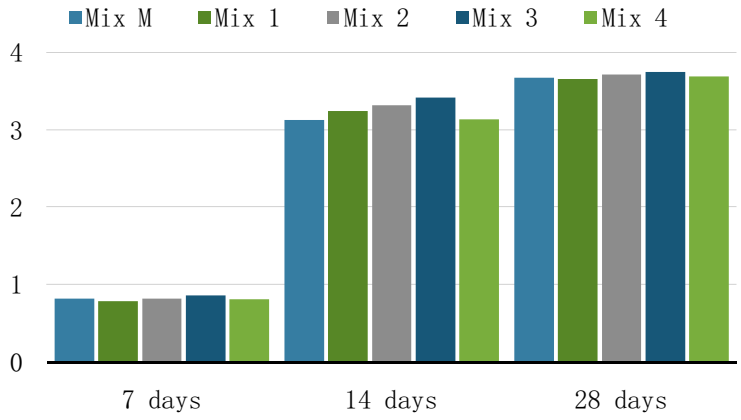

Figure 6 Graph of the comparison of tensile strength of concrete

3.3. Durability Test

3.3.1. Acid Attack Test

The acid attack testing procedure was conducted by immersing concrete cube specimens of 150 mm size after the specified initial curing in a tub containing 5% H2SO4 for 60 days as shown in Figure 4. The degree of attack was evaluated by measuring the expansion of concrete cubes, compressive strength, and weight losses of the specimens. The weight loss is calculated as,

% of weight lost = (Wb-Wa) x 100/Wb

3.3.2. Sulphate Attack Test

The sulphate attack testing procedure was conducted by immersing concrete cube specimens of 150 mm size after the specified initial curing in a tub containing 5% Sodium Sulphate for 60 days. The sulphate solution was replaced whenever the pH value exceeded 9.5. The weight loss is calculated as,

% of weight lost = (Wb-Wa) x 100/Wb

where

Wb = weight of specimen before attack

Wa = weight of specimen after attack

Table 9 Durability test result

S. No	Acid Attack		Sulphate attack	
	Loss in weight (%)	Loss in strength (%)	Loss in weight (%)	Loss in strength (%)
1	1.05	8	0.2	6.6
2	1.12	8.45	0	6.4
3	1.19	8.72	0	6.4
4	1.24	9.20	0	6.5
5	1.30	9.50	0	6.4

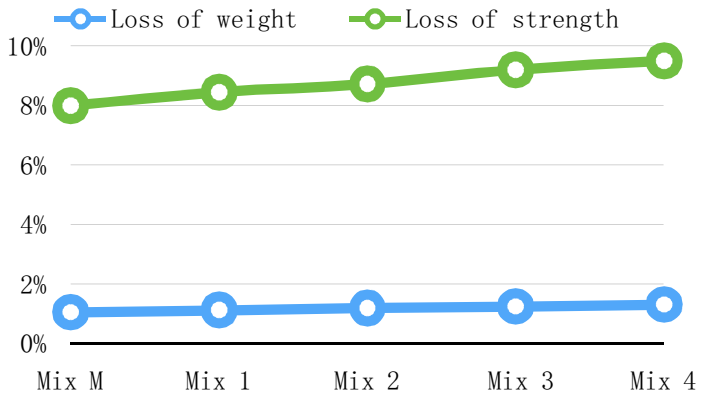

Figure 7 Graph of the comparison of acid attack test

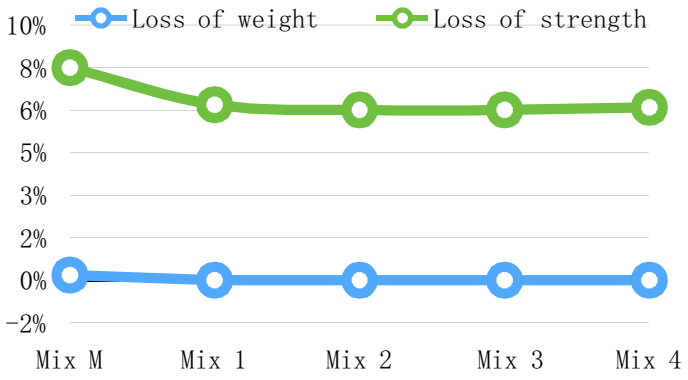

Figure 8 Graph of the comparison of sulphate attack test

4. CONCLUSION

The experimental investigation of use of plastic scraps in self compacting concrete have been concluded from the experimental tests,

- Thus by efficiently disposing the plastic waste which can be regenerated in improving the strength of the concrete.
- Thus the plastic waste scraps can be successfully used as a partial replacement for fine aggregate in concrete.
- The optimum result is achieved by the addition of 15% of plastic scrap to the mix.
- Beyond the addition of 15%, the strength is decreasing.
- Thus the bonding property upto addition of 15% gives a good result in both in tensile and compression.

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